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INT CL[5] H04R 1/20 1/32 1/40 3/00
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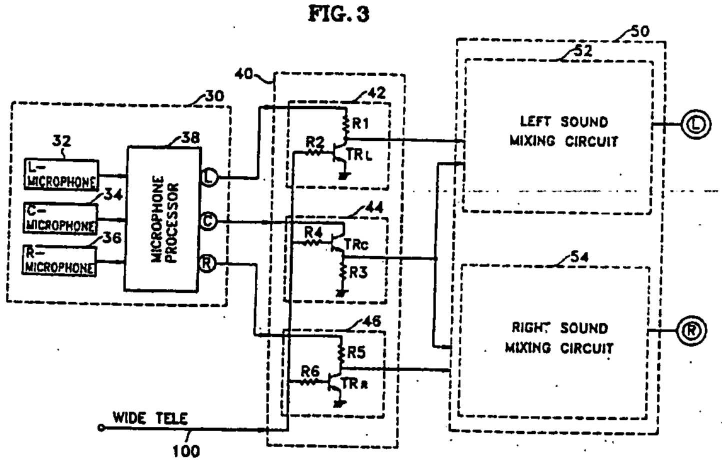
(54) Video camera microphone circuits

(57) The microphone circuit uses an analog circuit for audio signal processing in an audio section of the camcorder. A compound microphone 30 converts the sound generated by a subject into electrical signals to be amplified, and an analog sound catcher 40 receives a wide/tele signal 10 which changes according to the location of a zoom lens aiming to catch an image of the subject, and changes and outputs the electrical audio signals input from the microphone 30. The analog sound catcher 40 comprises circuits 42, 44 and 46, each of which utilizes the dynamic resistance of a respective transistor TR_L, TR_C and TR_L to vary the level of the microphone outputs. A sound mixer 50 receives the outputs of the analog sound catcher 40 and performs push-pull amplification and outputs the result, thereby to enable smooth sound processing and a reduction of the number of parts needed.

FIG. 3



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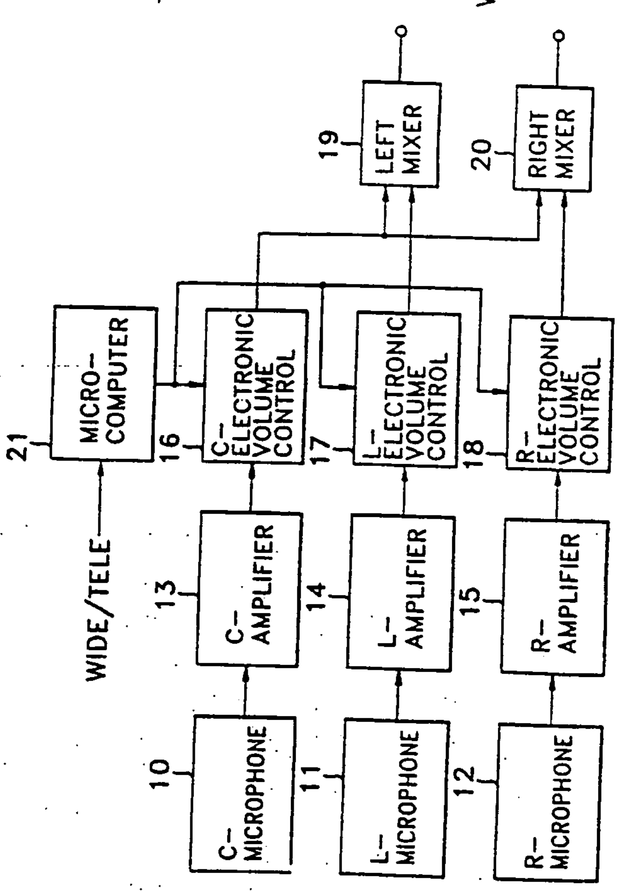


FIG. 1 (PRIOR ART)

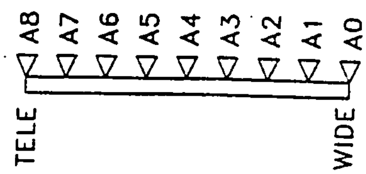


FIG. 2
(PRIOR ART)

FIG. 4

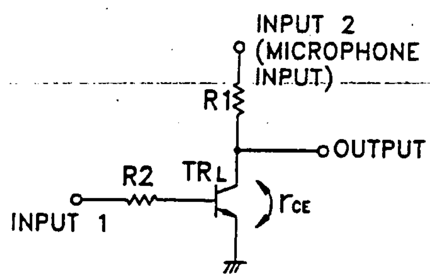


FIG. 5

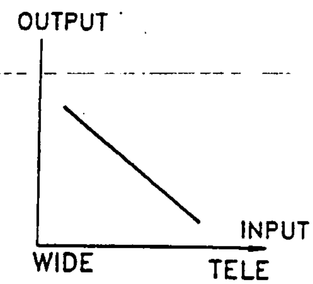


FIG. 6

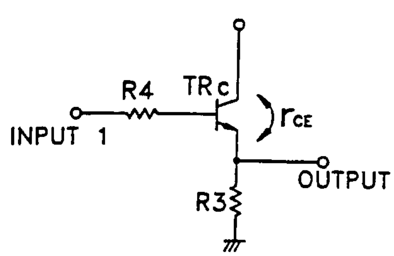


FIG. 7

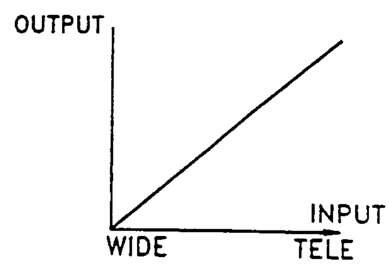


FIG. 8

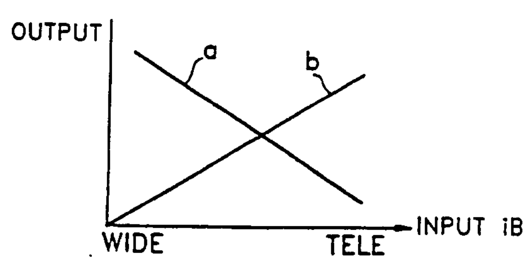


FIG. 3

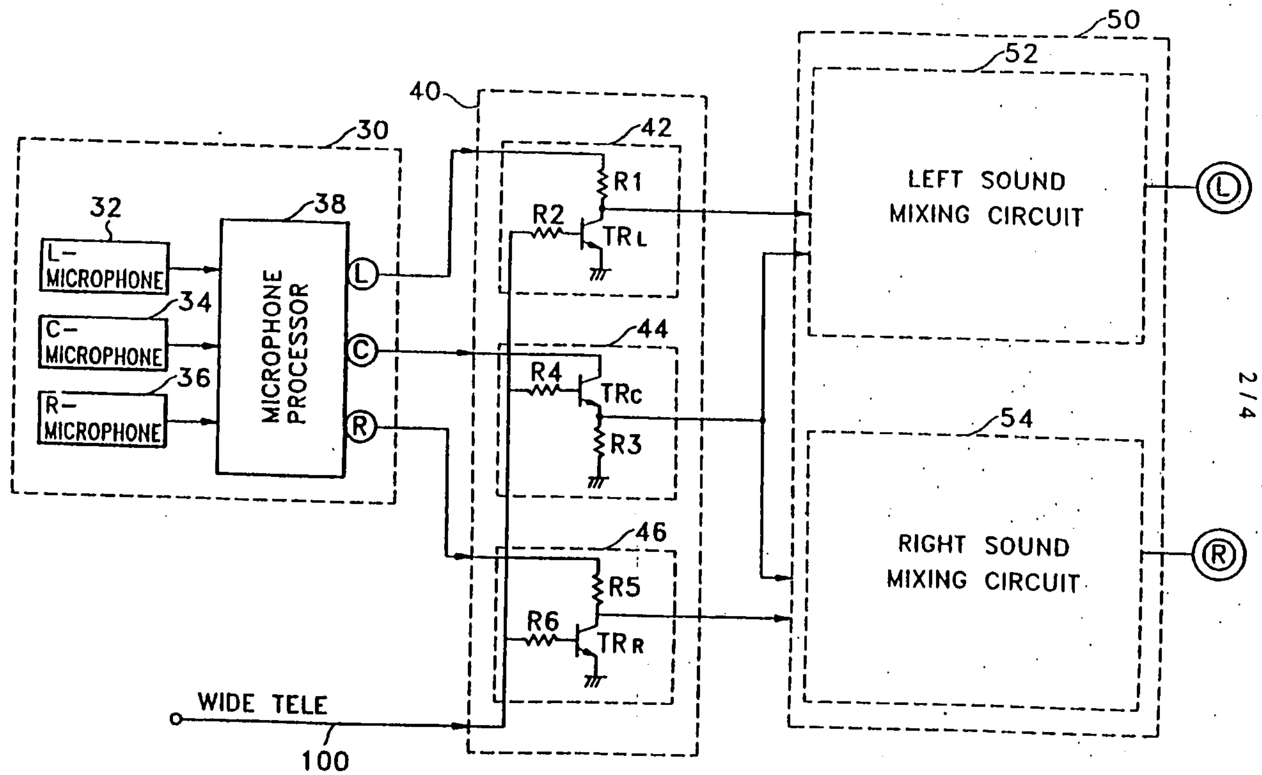
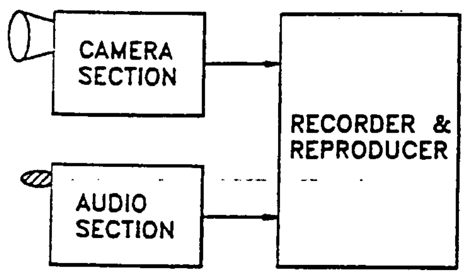

30
32
L-MICROPHONE
34
C-MICROPHONE
36
R-MICROPHONE
38
MICROPHONE PROCESSOR
L
C
R
40
42
R1
R2
TRL
44
R4
TRc
R3
46
R5
R6
TRR
WIDE TELE
100
50
52
LEFT SOUND MIXING CIRCUIT
54
RIGHT SOUND MIXING CIRCUIT
L
R

FIG. 9



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VIDEO CAMERA MICROPHONE CIRCUITS

The present invention relates to video camera microphone circuits which provide sound which accords to an image.

Generally, in a video camera and recorder (camcorder) for a typical consumer, which simultaneously records an image and sound, the image part of the camcorder has a zoom function in order to catch a life-like image using an optical lens. However, the audio section usually comprises a general-purpose microphone which lacks a life-like sound level of quality. Accordingly, the visual sense and the hearing sense can be mis-matched since the visual distance from a camcorder to the subject changes in the case of an image, but the sound does not change three-dimensionally with regard to the distance. To improve this problem, a function wherein audio amplitude changes in proportion to a change of zoom magnification of an optical lens, that is, a sound catch function having unified image and sound qualities, is needed.

Figure 1 of the accompanying diagrammatic drawings is a block diagram showing a sound-catch microphone of a video camera according to a conventional digital method. Referring to Figure 1, the conventional microphone comprises a central (C) microphone 10, a left (L) microphone 11, a right (R) microphone 12, a central amplifier 13, a left amplifier 14, a right amplifier 15, a central electronic volume control 16, a left electronic volume control 17, a right electronic volume control 18, a micro-computer 21, a left mixer 19, and a right mixer 20. For life-like audio input, the audio signal input from the centre, left and right microphones 10, 11 and 12 is firstly amplified in C, L and R amplifiers 13, 14 and 15, and then, is input to

electronic volume controls 16, 17 and 18. Then, the outputs of amplifiers 13, 14, and 15 are adjusted appropriately in C, L and R electronic volume controls 16, 17 and 18 in accordance with a control signal input from micro-computer 21, and output to L and R mixers 19 and 20. Left mixer 19 adds the output of C electronic volume control 16 to that of L electronic volume control 17, and amplifies the result. Right mixer 20 adds the output of C electronic volume control 16 to that of R electronic volume control 18, and amplifies the result. At this time, micro-computer 21 inputs from a camera section (not shown) a wide/tele signal which changes depending on the location of a zoom lens, and outputs the control signal according to the wide/tele signal so as to express the distance of the sound. Therefore, the outputs of amplifiers 13, 14 and 15 are input to the relevant electronic volume controls 16, 17 and 18, and are adjusted according to the control signal. That is, the wide/tele signal detects the location of the zoom lens in a video part (the camera section which is not shown) of a camcorder. Then the detected location is changed into a direct current voltage, and is input from the camera section (not shown) to micro-computer 21, having been divided into eight steps, i.e. from A1[V] to A8[V].

Figure 2 of the accompanying diagrammatic drawings shows an embodiment of detecting the wide/tele signal by eight steps according to the location of the conventional zoom lens. The detected voltage of eight steps and the corresponding changes of the electronic volume control can be expressed as in the following Table 1.

< Table 1 >

zoom lens location	voltage [V]	electronic volume control {left,right}	electronic volume control {centre}
A0	0	0dB	1dB
A1	0.6	−2dB	3dB
A2	1.1	−4dB	5dB
.	.	.	.
.	.	.	.
A8	3.2	−20dB	15dB

Here, the zoom lens location is divided into eight steps from A1 to A8 depending on the distance, having been gradually offset from A0, i.e. the reference and nearest point from the camera, as shown in Figure 2. The wide/tele voltage varies in steps like 0, 0.6, 1.1,... 3.2 [V] depending on the location of the zoom lens, which then results in the discontinuous change of L and R electronic volume controls 17 and 18 as 0, −2, −4,... −20 [dB], and also the discontinuous change of C electronic volume control 16 as 1, 3, 5,... 15 [dB]. That is, the central audio input signal is enlarged when the location of the zoom lens in Figure 2 goes from "wide" to "tele" (which means that the distance on the screen is shortened) and the level of central audio input signal is lowered when the location of zoom lens in Figure 2 goes from "tele" to "wide" (which means that the distance on the screen is elongated). For example, the human voice is heard loudly when the location of the zoom lens goes from "wide" to "tele" and is heard low when the location of the zoom lens goes from "tele" to "wide". Since the value of the electronic volume control method is fixed to eight discrete steps, the sound

feels discontinuous when the volume changes. In addition to this, since a micro-computer is needed so as to control the electronic volume operation, the manufacturing cost is high.

Preferred embodiments of the present invention aim to provide a sound catch microphone for a camcorder whose sound response is smooth and whose cost of required parts is curtailed, by using an analog circuit for an audio signal process in an audio section of the circuit.

It is another aim to provide a camcorder wherein a sound catch microphone is provided.

According to one aspect of the present invention, there is provided a microphone circuit for a video camera, the circuit comprising:

input means for receiving a wide/tele signal that changes according to the position of a zoom lens of a respective camera;

a plurality of microphones which convert the sound of a subject into an electrical signal to be amplifed;

a plurality of analog sound catch circuits which adjust the level of output signals from said microphones according to said wide/tele signal, using the dynamic resistance of a transistor; and

a plurality of sound mixers which sum and amplify the outputs of said plurality of sound catch circuits.

Preferably, said plurality of microphones comprise a left microphone which inputs left sound, a right microphone which inputs right sound, a centre microphone which inputs centre sound, and a microphone processor which amplifies and outputs of said left, right and centre microphones.

Preferably, said plurality of analog sound catch circuits comprise a centre sound catch circuit which adjusts a centre audio signal input from said microphone processor in proportion to the change of said wide/tele signal, a left sound catch circuit which adjusts a left audio signal input from said microphone processor in inverse proportion to the change of said wide/tele signal, and a right sound catch circuit which adjusts a right audio signal input from said microphone processor in inverse proportion to the change of said wide/tele signal.

Preferably, said plurality of sound mixers comprise a left sound mixer which sums and amplifies the outputs of said centre and left sound catch circuits and a right sound mixer which sums and amplifies the outputs of said centre and right sound catch circuits.

The invention extends to a video camera comprising a zoom lens, means for generating a wide/tele signal that changes according to the position of the zoom lens, and a microphone circuit according to any of the preceding aspects of the invention.

According to another aspect of the present invention, there is provided a camcorder comprising:

a camera section which forms an image of a subject through an optical lens, converts the image into a video signal, and generates a wide/tele signal in accordance with a zooming state;

an audio processing part which receives the sound of said subject through a plurality of microphones, converts the input sound into an audio signal, and amplifies said audio signal according to the level of said wide/tele signal, using the dynamic resistance of a transistor; and

a recorder/reproducer which records and reproduces the outputs of said camera section and audio processing part onto or from a recording medium.

Preferably, the audio processing part includes a microphone circuit according to any of the preceding aspects of the invention.

For a better understanding of the invention, and to show how embodiments of the same may be carried into effect, reference will now be made, by way of example, to Figures 3 to 9 of the accompanying diagrammatic drawings, in which:

Figure 3 is a circuit diagram showing one example of a sound catch microphone circuit according to the present invention;

Figure 4 is a detail circuit diagram showing a left sound catch circuit of Figure 3;

Figure 5 is a graphical representation showing an output characteristic according to input current of the left sound catch circuit of Figure 4;

Figure 6 is a detail circuit diagram showing a central sound catch circuit of Figure 3;

Figure 7 is a graphical representation showing an output characteristic according to input current of the central sound catch circuit of Figure 6;

Figure 8 is a graphical representation showing the input/output characteristic of the left sound catch circuit of Figure 5 and the central sound catch circuit of Figure 7; and

Figure 9 is a schematic diagram showing the structure of a camcorder that is another embodiment of the present invention.

Referring to Figure 3, the sound catch microphone circuit comprises a compound stereophonic microphone 30, an analog sound catcher 40 and a sound mixer 50. The compound microphone 30 comprises a central microphone 34, a left microphone 32, a right microphone 36 and a microphone processor 38. Analog sound catcher 40 is made of a left sound catch circuit 42, a central sound catch circuit 44 and a right sound catch circuit 46. Sound mixer 50 is made of a left sound mixing circuit 52 and a right sound mixing circuit 54. Thus, the compound microphone 30 consists of L microphone 32, R microphone 36 and C microphone 34, which enables the sound to be input and converted into an electrical sound signal (audio signal). The audio signal which is input from microphones 32, 34 and 36 is amplified by microphone processor 38, and the amplified signal is then output to analog sound catcher 40. Sound catch circuits 42, 44 and 46 of analog sound catcher 40 receive a wide/tele input signal generated from a camera section (not shown) through a terminal 100. Wide/tele signal is a direct

current voltage which continuously changes according to the location of the zoom lens of the camera section. That is, the direct current voltage of wide/tele signal is increased since the subject comes closer on screen when the location of the zoom lens goes from "wide" to "tele", while the direct current voltage of wide/tele signal is decreased since the subject goes further away on screen when the location of the zoom lens goes from "tele" to "wide". The direct current voltage of wide/tele signal is input to the respective bases of transistors TR_L, TR_R and TR_C of sound catch circuits 42, 44 and 46. Sound catcher 40 changes the amplitude of the audio signal which is input from the respective microphones according to the wide/tele signal voltage and gives a life-like quality to the sound considering the image of the external environment. That is, the central audio output signal is enlarged when the location of the zoom lens of the camera section moves from "wide" to "tele" since the subject comes closer on screen. On the contrary, the central audio input signal becomes smaller when the location of the zoom lens of the camera section moves from "tele" to "wide" since the subject goes further away on screen. For example, a voice of a person in front is heard loudly when the location of the zoom lens goes from "wide" to "tele" and is heard softer when the location of the zoom lens goes from "tele" to "wide". Left mixing circuit 52 sums the output of central sound catch circuit 44 with the output of left sound catch circuit 42, and amplifies and the summed signal them. Right mixing circuit 54 sums the output of central sound catch circuit 44 with the output of right sound catch circuit 46, and amplifies and outputs the summed signal.

Figure 4 is a detail circuit diagram showing the left sound catch circuit 42 of Figure 3. Since the structures and operations of the left sound catch circuit and the right sound catch circuit are similar, only the left sound catch

circuit will be explained. Referring to Figure 4, the left sound catch circuit consists of transistor TR_L, resistor R2 which is connected to the base of transistor TR_L, and resistor R1 which is connected to the collector of transistor TR_L. Referring to Figure 4, r_{CE} is the dynamic resistance between the collector and the emitter of the transistor. The wide/tele signal is input from a camera section to a first input terminal, which then is input to the base of transistor TR_L through resistor R2. The wide/tele signal is a direct current voltage signal which changes continuously according to the change of the location of the zoom lens. When the direct current voltage is input to the base of transistor TR_L, a base input current i_B is also changed according to the input direct current voltage. Meanwhile, the audio signal is input to a second input terminal from microphone processor (38 of Figure 3), which then is connected to the collector of transistor TR_L through resistor R1. Accordingly, when the current i_B which is input to the base of transistor TR_L increases, the output of transistor TR_L decreases inversely proportional to the increase of the input current i_B, since the r_{CE} value, i.e. TR_L's own dynamic resistance value, decreases. Here, the output voltage (V_{OL}) can be calculated as the following expression:

$$V_{OL} = \left(\frac{r_{CE}}{R_1 + r_{CE}}\right) \text{Input2} \quad \ldots (1)$$

Here, r_{CE} is the dynamic resistance of the transistor itself. Output voltage signal (V_{OL}) decreases as the dynamic resistance r_{CE} decreases, as shown in expression (1). Accordingly, when the zoom lens goes from "wide" to "tele", the output voltage signal (V_{OL}) decreases because the input current i_B increases in accordance with the increase of the direct current (DC) voltage value of the wide/tele signal.

Figure 5 is a graphical representation showing the relation between the input current i_B and output voltage signal (V_{OL}) according to the left sound catch circuit of Figure 4, wherein the horizontal axis indicates an input current i_B signal and the vertical axis indicates an output voltage signal (V_{OL}). Referring to the graph of Figure 5, input current i_B increases as the zoom lens goes from "wide" to "tele", while output voltage signal (V_{OL}) decreases as input current i_B increases.

Figure 6 is a detail circuit diagram showing the central sound catch circuit 44 of Figure 3. Referring to Figure 6, the central sound catch circuit is made of a transistor TR_C, a resistor R4 connected to the base of transistor TR_C, and a resistor R3 connected to the emitter of transistor TR_C. The wide/tele signal is input from the camera section to a first input terminal, which then is input to the base of transistor TR_C through resistor R4. The wide/tele signal is a direct current voltage signal which changes continuously in accordance with the change of the location of the zoom lens. When the direct current voltage is input to the base of transistor TR_C, the current i_B input to the base varies in accordance with the input voltage. Meanwhile, the central audio signal is input to a second input terminal from microphone processor (38 of Figure 3). Accordingly, when the current i_B input to the base of transistor TR_C increases, the output of transistor TR_C increases in proportion to the increase of the input current i_B, since the r_{CE} value, i.e. transistor TR_C's own dynamic resistance value, decreases. Here, the output voltage (V_{OC}) can be calculated as the following expression:

$$V_{oc} = \left(\frac{R_3}{R_3+r_{CE}}\right) \text{Input2} \quad \ldots (2)$$

As shown in expression (2), when input current i_B increases, output voltage (V_{OC}) also increases while dynamic resistance r_{CE} decreases. Accordingly, when the zoom lens goes from "wide" to "tele", the direct current voltage of the wide/tele signal increases, thereby increasing input current i_B and output voltage (V_{OC}).

Figure 7 is a graphical representation showing the relation of the output voltage (V_{OC}) according to the input current of the central sound catch of Figure 6, wherein the horizontal axis indicates input current i_B signal and the vertical axis indicates the output voltage (V_{OC}) signal. Referring to the graph of Figure 7, input current i_B increases as the zoom lens goes from "wide" to "tele", while output voltage (V_{OC}) signal increases in proportion to the increase of input current i_B.

Figure 8 which combines Figure 5 and Figure 7 is a graphical representation showing the relation wherein the left and right sound catch circuits and central sound catch circuit change depending on input current i_B.

Referring to Figure 8, the horizontal axis indicates input current i_B while the vertical axis indicates output voltage signal. Input current i_B increases as the zoom lens goes from "wide" to "tele". When input current i_B increases, output of the left and right sound catch circuits decreases as shown in graph 'a', while output of the central sound catch circuit increases as shown in graph 'b'. On the contrary, when the zoom lens goes from "tele" to "wide", input current i_B decreases, and then output of the left and right sound catch circuits increases as shown in graph 'a', while output of the central sound catch circuit decreases as shown in graph 'b'. Accordingly, when the zoom lens goes from "wide" to "tele" which means that a subject

is coming closer, the audio inputs from the left and right microphones decrease while the audio input from the central microphone increases. As a result, the audio signal generated in front is heard louder and louder while the audio signal generated from the side is heard softer and softer, which gives an effect of having a conformity with an image. Conversely, when the zoom lens goes from "tele" to "wide" which means that the subject gradually goes further away, the audio signal input from the left and right microphones is heard louder while the audio signal input from the central microphone is heard softer.

Figure 9 is a schematic illustration showing the structure of a camcorder of another embodiment of the present invention, wherein a camera section 80, audio section 82 and a recorder/reproducer 84 are provided. Referring to Figure 9, the camera section 80 and recorder/reproducer 84 may be as in a conventional device, and the audio section 82 is provided with a sound catch microphone circuit embodying the present invention as described in Figure 3. That is, the camera section 80 picks up the subject through an optical lens and converts the picked-up subject into a video signal and generates the wide/tele signal in accordance with zooming. The audio section 82 inputs the sound of the subject into a number of microphones and converts the input sound into an audio signal, and then performs an analog processing on the audio signal according to the wide/tele signal, and then outputs the audio signal that accords to the distance of the caught image. The recorder/reproducer 84 inputs the video and audio signals and records and reproduces them on and from a video tape, or other medium.

The illustrated embodiments of the present invention use a sound catch circuit which employs an analog signal processing method, which enables a

natural connection of the change of the sound. Also, the construction of a simple circuit utilizing the dynamic resistance characteristic of a transistor enables the number of parts and the cost of the circuit to be lowered.

The reader's attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

Each feature disclosed in this specification (including any accompanying claims, abstract and drawings), may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

The invention is not restricted to the details of the foregoing embodiment(s). The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

CLAIMS

1. A microphone circuit for a video camera, the circuit comprising:

input means for receiving a wide/tele signal that changes according to the position of a zoom lens of a respective camera;

a plurality of microphones which convert the sound of a subject into an electrical signal to be amplifed;

a plurality of analog sound catch circuits which adjust the level of output signals from said microphones according to said wide/tele signal, using the dynamic resistance of a transistor; and

a plurality of sound mixers which sum and amplify the outputs of said plurality of sound catch circuits.

2. A microphone circuit according to claim 1, wherein said plurality of microphones comprise a left microphone which inputs left sound, a right microphone which inputs right sound, a centre microphone which inputs centre sound, and a microphone processor which amplifies and outputs of said left, right and centre microphones.

3. A microphone circuit according to claim 2, wherein said plurality of analog sound catch circuits comprise a centre sound catch circuit which adjusts a centre audio signal input from said microphone processor in proportion to the change of said wide/tele signal, a left sound catch circuit which adjusts a left audio signal input from said microphone processor in

inverse proportion to the change of said wide/tele signal, and a right sound catch circuit which adjusts a right audio signal input from said microphone processor in inverse proportion to the change of said wide/tele signal.

4. A microphone circuit according to claim 3, wherein said plurality of sound mixers comprise a left sound mixer which sums and amplifies the outputs of said centre and left sound catch circuits and a right sound mixer which sums and amplifies the outputs of said centre and right sound catch circuits.

5. A microphone circuit for a video camera, the circuit being substantially as hereinbefore described with reference to Figures 3 to 8 of the accompanying drawings.

6. A video camera comprising a zoom lens, means for generating a wide/tele signal that changes according to the position of the zoom lens, and a microphone circuit according to any of the preceding claims.

7. A camcorder comprising:

a camera section which forms an image of a subject through an optical lens, converts the image into a video signal, and generates a wide/tele signal in accordance with a zooming state;

an audio processing part which receives the sound of said subject through a plurality of microphones, converts the input sound into an audio signal, and amplifies said audio signal according to the level of said wide/tele signal, using the dynamic resistance of a transistor; and

a recorder/reproducer which records and reproduces the outputs of said camera section and audio processing part onto or from a recording medium.

8. A camcorder according to claim 7, wherein the audio processing part includes a microphone circuit according to any of claims 1 to 5.

Patents Act 1977 Examiner's report to the Comptroller under Section 17 .e Search report)	Application number GB 9402388.4
Relevant Technical Fields (i) UK Cl (Ed.M) H4J (JA,JGF,JGP) (ii) Int Cl (Ed.5) H04R 1/20, 1/32, 1/40, 3/00	Search Examiner P J EASTERFIELD Date of completion of Search 11 MARCH 1994
Databases (see below) (i) UK Patent Office collections of GB, EP, WO and US patent specifications. (ii) ONLINE DATABASES: WPI	Documents considered relevant following a search in respect of Claims :- 1 to 8

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E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages	Relevant to claim(s)
A	GB 2071459 A (NIPPON VICTOR)	
A	GB 2062406 A (NIPPON VICTOR)	
A	GB 2050111 A (NIPPON VICTOR)	
A	EP 0343675 A (MATSUSHITA)	

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